

REMARKS

I. Introduction

With the addition of claims 35 and 36 herein, claims 23 to 36 are pending in the present application. In view of the foregoing amendments and the following remarks, it is respectfully submitted that all of the presently pending claims are allowable and reconsideration is respectfully requested.

II. Objections to the Drawings

As regards the objection to figure 3, Applicants herewith provide a replacement sheet including figure 3, which corrects the lead line to entry plane 110. No new matter has been added.

The Final Office Action raised several objections to the drawings under 37 C.F.R. § 1.83(a). As regards “fuel injection system of an internal combustion engine,” the preamble of claim 23 recites “[a] fuel injector for a fuel injection system of an internal combustion engine.” As stated, for example, on page 3, lines 23 to 25 of the Specification, Figure 1 illustrates “an example of an embodiment in the form of an injection valve for the fuel injection system of an internal combustion engine.” Thus, it is respectfully submitted that the Figures adequately illustrate “[a] fuel injector of a fuel injection system of an internal combustion engine” and that an illustration of “a fuel injection system of an internal combustion engine” is unnecessary.

As regards “direct injection of a fuel into a combustion chamber of the internal combustion engine,” claim 24 recites that “the fuel injector is configured for a direct injection of a fuel into a combustion chamber of the internal combustion engine.” The Specification states, for example, at page 3, lines 27 to 28 with reference to Figure 1 that “[t]his fuel injector is especially suitable as a high-pressure injection valve **for direct injection of fuel into the combustion chamber of an internal combustion engine**” (emphasis added). Thus, it is respectfully submitted that Figure 1, for example, adequately illustrates “[a] fuel injector . . . configured for a direct injection of a fuel into a combustion chamber of [an] internal combustion engine.”

As regards “entry plane,” as indicated above, Figure 3 has been amended herein to correctly indicate an entry plane 110.

As regards the “projection,” it is respectfully submitted that Figure 3 adequately illustrates that “an entry plane is completely covered by a projection of [a] flattened face into the entry plane in a direction perpendicular to the flattened face” as recited in claim 23.

In view of the foregoing, withdrawal of all objections to the drawings is respectfully requested.

III. Objection to Claim 24 Under 37 C.F.R. § 1.75(c)

As regards the objection to claim 24, while Applicants do not necessarily agree with the merits of this objection, to facilitate matters, claim 24 has been amended herein without prejudice to recite that “the fuel injector is configured for a direct injection of a fuel into a combustion chamber of the internal combustion engine.” It is therefore respectfully submitted that the present objection is moot, and withdrawal of this objection is respectfully requested.

IV. Rejection of Claim 31 Under 35 U.S.C. §112, First Paragraph

As regards the rejection of claim 31 under 35 U.S.C. § 112, first paragraph, the Examiner’s attention is directed, for example, to original claim 9, which recites that “the swirl channels (93) not being connected to the outer periphery of the swirl element (47) by a peripheral edge area (96).” It is respectfully submitted that at least original claim 9 provides an adequate written description for the limitation that “the plurality of swirl channels is not connected to an outer periphery of the disk-shaped swirl element by a peripheral edge area” as recited in claim 31. Withdrawal of this rejection is therefore respectfully requested.

V. Rejection of Claims 30 and 34 Under 35 U.S.C. §112, Second Paragraph

As regards the rejection of claim 30 under 35 U.S.C. § 112, second paragraph, while Applicants do not necessarily agree with the merits of this rejection, to facilitate matters, claim 30 has been amended herein without prejudice to recite that the valve seat element includes a spray element which includes the outlet orifice and is arranged downstream from the valve seat face. Support for the amendment to claim 30 may be found, for example, in Figures 3 and 6.

While the Final Office Action states that claim 33 was rejected under 35 U.S.C. § 112, second paragraph, the Final Office Action refers to an alleged lack

of antecedent basis in claim 34. Thus, it is believed that reference to claim 33 was made in error and that claim 34 was intended to have been rejected. Clarification is nevertheless requested. As regards claim 34, the Examiner will note that claim 34 has been amended herein without prejudice to change "the entry plane" to --an entry plane--, thereby obviating the present rejection of claim 34.

In view of the foregoing, withdrawal of this rejection is respectfully requested.

VI. Rejection of Claims 23 to 34 Under 35 U.S.C. § 103(a)

Claims 23 to 34 were rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of U.S. Patent No. 4,890,794 ("Imafuku et al.") and U.S. Patent No. 5,878,962 ("Shen et al."). For the reasons more fully set forth below, Applicants respectfully submit that the combination of Imafuku et al. and Shen et al. does not render obvious claims 23 to 34 for the reasons set forth below.

Claim 23 relates to a fuel injector for a fuel injection system of an internal combustion engine. Claim 23 recites an energizable actuating element, a valve needle that is axially movable along a longitudinal axis of a valve, a fixed valve seat, a valve seat element including an orifice following downstream from the fixed valve seat, a valve closing section arranged on a downstream end of the valve needle and for working together with the fixed valve seat for opening and closing the valve. Claim 23 further recites that the fixed valve seat is designed on the valve seat element, a flattened face running perpendicular to the longitudinal axis of the valve and being arranged on the downstream end of the valve closing section downstream from the fixed valve seat, and a swirl-producing element arranged upstream from the fixed valve seat and downstream of the guide element, wherein the flattened face includes a diameter d that is greater than a diameter D of an outlet orifice, and the outlet orifice is arranged such that an entrance to the outlet orifice is completely covered by a projection of the flattened face into the entrance in a direction perpendicular to the flattened face. Claim 23 has been amended herein without prejudice to recite that a guide element includes alternating recesses and tooth-shaped projecting areas, the recesses configured to channel fuel through the guide element. Support for the amendment to claim 23 may be found, for example, in Figure 8.

The Final Office Action alleges that Imafuku et al. disclose a fuel injector comprising an energizable actuating element 14, a valve needle 27, a fixed valve seat 48, a valve seat element 9, 55, an orifice 54a, b, a valve closing section 47, a flattened face (downstream end of 45), an outlet orifice (outlet of orifice 54 a, b). The Final Office Action admits that Imafuku et al. do not disclose a swirl-producing element. The Final Office Action alleges that Shen et al. disclose a swirl-producing element 38, 48 upstream of a fixed valve seat 34.

Imafuku et al. do not disclose, or even suggest, a configuration which has a guide element that includes alternating recesses and tooth-shaped projecting areas, the recesses configured to channel fuel through the guide element. As illustrated in Figure 2, Imafuku et al. provide a nozzle body 9 which contacts a cylindrical section 43 at a valve seat 48. The nozzle body 9 is merely provided with a frusto-conical section. Imafuku et al. do not disclose or suggest any configuration which has a guide element that includes alternating recesses and tooth-shaped projecting areas, the recesses configured to channel fuel through the guide element. The addition Shen et al. does not cure the critical deficiencies of Imafuku et al. Shen et al. allegedly relate to a pressure swirl injector with angled cone spray for fuel injection. Shen et al. provide a pin 20 which translates in a vertical orientation and contacts an end plate 30. A swirler plate 48 is placed underneath a disk 38. The disk 38 is thereafter placed inside a cavity 36. Shen et al., contrary to the requirements of amended claim 23, provide a disk with an axial turned continuous flange 40. Fig. 2, col. 3, lines 45 to 50. Consequently, Shen et al. do not disclose or suggest any configuration in which a guide element includes alternating recesses and tooth-shaped projecting areas, the recesses configured to channel fuel through the guide element.

In rejecting a claim under 35 U.S.C. § 103(a), the Examiner bears the initial burden of presenting a *prima facie* case of obviousness. *In re Rijckaert*, 9 F.3d 1531, 1532, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993). To establish *prima facie* obviousness, three criteria must be satisfied. First, there must be some suggestion or motivation to modify or combine reference teachings. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988). This teaching or suggestion to make the claimed combination must be found in the prior art and not based on the application disclosure. *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). Second, there must be a reasonable expectation of success. *In re Merck &*

Co., Inc., 800 F.2d 1091, 231 U.S.P.Q. 375 (Fed. Cir. 1986). Third, the prior art reference(s) must teach or suggest all of the claim limitations. *In re Royka*, 490 F.2d 981, 180 U.S.P.Q. 580 (C.C.P.A. 1974). As more fully set forth above, it is respectfully submitted that the combination of Imafuku et al. and Shen et al. does not disclose, or even suggest, all of the limitations of claim 23, including a guide element that includes alternating recesses and tooth-shaped projecting areas, the recesses configured to channel fuel through the guide element.

Moreover, it is respectfully submitted that the cases of *In re Fine*, *supra*, and *In re Jones*, 21 U.S.P.Q.2d 1941 (Fed. Cir. 1992), make plain that the Final Office Action's generalized assertions that it would have been obvious to modify or combine the references do not properly support a § 103 rejection. It is respectfully submitted that those cases make plain that the Final Office Action reflects a subjective "obvious to try" standard, and therefore does not reflect the proper evidence to support an obviousness rejection based on the references relied upon. In particular, the Court in the case of *In re Fine* stated that:

The PTO has the burden under section 103 to establish a *prima facie* case of obviousness. It can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. This it has not done. . . .

Instead, the Examiner relies on hindsight in reaching his obviousness determination. . . . One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.

In re Fine, 5 U.S.P.Q.2d at 1598 to 1600 (citations omitted; italics in original; emphasis added). Likewise, the Court in the case of *In re Jones* stated that:

Before the PTO may combine the disclosures of two or more prior art references in order to establish *prima facie* obviousness, there must be some suggestion for doing so, found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. . . .

Conspicuously missing from this record is any evidence, other than the PTO's speculation (if it be called evidence) that one of ordinary skill . . . would have been motivated to make the modifications . . . necessary to arrive at the claimed [invention].

In re Jones, 21 U.S.P.Q.2d at 1943, 1944 (citations omitted; italics in original).

That is exactly the case here since it is believed and respectfully submitted that the present Final Office Action offers no evidence whatsoever, but only conclusory hindsight, reconstruction and speculation, which these cases have indicated does not constitute evidence that will support a proper obviousness finding. Unsupported assertions are not evidence as to why a person having ordinary skill in the art would be motivated to modify or combine references to provide the claimed subject matter of the claims to address the problems met thereby. Accordingly, the Office must provide proper evidence of a motivation for modifying or combining the references to provide the claimed subject matter.

More recently, the Federal Circuit in the case of *In re Kotzab* has made plain that even if a claim concerns a “technologically simple concept” -- which is not the case here -- there still must be some finding as to the “specific understanding or principle within the knowledge of a skilled artisan” that would motivate a person having no knowledge of the claimed subject matter to “make the combination in the manner claimed,” stating that:

In this case, the Examiner and the Board fell into the hindsight trap. The idea of a single sensor controlling multiple valves, as opposed to multiple sensors controlling multiple valves, is a technologically simple concept. *With this simple concept in mind, the Patent and Trademark Office found prior art statements that in the abstract appeared to suggest the claimed limitation. But, there was no finding as to the specific understanding or principle within the knowledge of a skilled artisan that would have motivated one with no knowledge of Kotzab’s invention to make the combination in the manner claimed.* In light of our holding of the absence of a motivation to combine the teachings in Evans, we conclude that the Board did not make out a proper *prima facie* case of obviousness in rejecting [the] claims . . . under 35 U.S.C. Section 103(a) over Evans.

In re Kotzab, 55 U.S.P.Q.2d 1313, 1318 (Fed. Cir. 2000) (emphasis added). Again, it is believed that there have been no such findings.

Accordingly, there is no evidence that the references relied upon, whether taken alone, combined or modified, would provide the features and benefits of claim 23. It is therefore respectfully submitted that claim 23 is allowable for these reasons.

The purpose of Shen et al. is to provide constantly swirling fuel **upstream** of an orifice through the use of a “swirler.” Shen et al. require a conical

spray pattern which is characterized by a conical sheet of swirling fuel about an axis 66 with substantially only a minor quantity of fuel within the conical sheet of the conical spray pattern. Col. 4, lines 20 to 23. Shen et al. require a smooth transition upstream of the orifice which has radially swirling fuel into a generally shallow conical swirl pattern about seat 34. Col. 4, lines 27 to 31. Shen et al. state:

In all of these embodiments, it will be appreciated that the swirl pattern afforded by the swirl plate carries through the frustoconical seat when the valve is open, as well as through the orifice in all of its various forms including the vent tubes. This is a result of smooth transitions made between a tangentially flowing fuel which continues its swirl pattern as it advances axially and is then turned in an angular direction. The lack of sharp corners and protuberances avoids flow turbulence and the smooth transition surfaces afford a continuation of the strong swirl effected by the swirl plate as the fuel passes through the open valve.

Col. 5, lines 23 to 32. Shen et al. therefore require a smooth transition of fluid flow (upstream of the orifice) for operability. Without a smooth transition upstream of the orifice, the apparatus described by Shen et al. would be inoperative and the purpose of the apparatus provided by Shen et al. would be defeated.

The Final Office Action proposes to add the swirl element of Shen et al. to Imafuku et al. It is respectfully submitted that placement of the Shen et al. swirl-producing element 38 in the Imafuku et al. injector would not be performed by a person of ordinary skill in the art as such a placement would not provide a smooth transition and is contrary to the purpose of Shen et al. If the swirl element of Shen et al. could be added to Imafuku et al., and Applicants do not concede that the swirl element can be added successfully, an abrupt transition would occur due to the sharp flat faced bottom face of tang 45 (again above the orifice). See Imafuku et al. Fig. 2. Shen et al. provide for a rounded frustoconical shape and hemispherical head of the nozzle to eliminate sharp or abrupt transitions to establish a smooth pre-flow of fluid. Addition of the Shen et al. swirl element to Imafuku et al. could not be performed without an abrupt transition as evidenced by the flat face of tang 45 in Imafuku et al. and thus the purpose of the apparatus described in Shen et al. would be defeated.

The Final Office Action alleges that Shen et al. at column 4, lines 35 to 40 describes that smoothness is not needed. Applicants respectfully traverse this

assertion. Shen et al. at column 4, lines 35 to 40 (as referred to in the Final Office Action) relates to angles **about** the orifice and not for flow regimes **above** the orifice. Shen et al. state:

Of course, angles about orifice 32 vary between the two large and shallow angles. However it is believed that the large angle does not deliteriously affect the swirl pattern of the fuel flow because the average angle is shallow and affords a smooth flow transition which maintains the swirl flow.

As provided above, a smooth flow transition is always desired and the angle **about** the orifice may be altered. Shen et al. require a smooth swirl pattern before the orifice. If a person of skill in the art would attempt to combine Shen et al. and Imafuku et al., (and it is not admitted that they can be combined), the sharp transition of the Imafuku et al. tang 45 would defeat the required smooth swirl pattern needed **before** the orifice as required in Shen et al. As a result, a person of skill in the art would not combine Shen et al. and Imafuku et al. as proposed since these references seek different outcomes.

Applicants also respectfully submit that Imafuku et al. has a valve needle 27 which ends downstream from the sealing seat in a cylindrical tang 45. The tang 45 is at the end away from the flow of valve needle 27 and is used to form a ring gap between cylindrical nozzle body opening 50 and tang 45 which maintains a constant cross section over its length (see column 3, lines 1 through 5). The length of the tang 45 is dimensioned so that when the fuel injector is closed, tang 45 does not extend out from the nozzle body opening 50. Tang 45 ends directly before a plane defined by an upper flat side 51 of the nozzle body 9. Tang 45 ends directly above the disk-shaped perforated body 55, which has a plurality of injection openings 54a,b. In order to prevent any closing off of the injection openings 54a,b and specifically, by tang 45 and the ring gap formed around it, to ensure an unhindered inflow of fuel into the injectors openings 54a,b, the injection openings 54a,b have been deliberately placed offset to tang 45 in perforated body 55 without any covering or overlapping. If a person were to insert a valve needle into a fuel injector as described in Shen et al., the spray discharge opening would simply be blocked. Valve needles having tang end pieces is only usable in fuel injectors in which there is a ring space deliberately provided in which there is a fluid flow about the tang. The constructive design of the valve needles of the two valve types

deviates between them so that an exchange of the valve needles is not possible, since non-functioning valves would be created. Consequently, it is respectfully submitted that it would not have been obvious to one skilled in the art to combine Imafuku et al. and Shen et al. to produce a functional fuel injector. Rather the proposed combination of Imafuku et al. and Shen et al. would result in a non-functional injector.

The fuel injector according to the present application may provide improved fuel preparation. The improvement of the preparation quality of the initial jet may be particularly noted. The initial jet is formed when the valve is closed and fuel has collected in front of the valve seat in an inner swirl chamber. When the valve is opened, the fuel flows towards the outlet opening positioned downstream from the valve seat in a largely axial and not swirl-like manner. Only directly after this pre-jet does the actual main jet follow, which is sprayed in a swirl, because it has passed through the swirl element. Due to the geometry of the fuel injector, the drop size of the fuel is reduced whereby a finer fuel spray is initiated. The energy loss of the fuel at the flattened region of the valve needle any previously harmful initial jet of fuel may be reduced. The homogeneity of the main jet may also be increased. Applicants respectfully submit that the cited references do not provide a configuration which provides these advantages.

In view of all of the foregoing, it is respectfully submitted that the combination of Shen et al. and Imafuku et al. does not render unpatentable claim 23.

As regards claims 24 to 33, which ultimately depend from claim 23 and therefore include all of the limitations of claim 23, it is respectfully submitted that the combination of Shen et al. and Imafuku et al. does not render unpatentable these dependent claims for at least the same reasons more fully set forth above in support of the patentability of claim 23. In re Fine, supra (any dependent claim that depends from a non-obvious independent claim is non-obvious).

As regards claim 34, claim 34 includes limitations analogous to limitations included in claim 23. It is respectfully submitted that the combination of Shen et al. and Imafuku et al. does not render unpatentable claim 34 for at least the same reasons more fully set forth above in support of the patentability of claim 23.

In view of all of the foregoing, withdrawal of this rejection is respectfully requested.

VII. Rejection of Claims 23 to 30 and 32 to 34 Under 35 U.S.C. §103(a)

Claims 23 to 30 and 32 to 34 were rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,996,912 ("Ren et al."). For the reasons more fully set forth below, Applicants respectfully submit that Ren et al. do not render obvious claims 23 to 30 and 32 to 34.

Ren et al. allegedly disclose a flat needle for a pressurized swirl fuel injector. Ren et al. provide a needle 14 which moves along an axis A, the needle 14 having a flattened face df. The needle 14 has an edge 50 which contacts a tapered surface 38 to block the flow of fuel traveling along the needle 14. Fluid for combustion travels along the periphery of the needle 14 down to a lower guide 32 and a metering swirl disk 34. The lower guide 32 has an internally configured opening 40 which transmits the flow of fluid through the lower guide 32. The metering swirl disk, similar to the lower guide 32, allows fluid to be transmitted through the disk 34 by an opening 42. Each of the guide 32 and the metering swirl disk 34 have the openings 40 and 42 for receiving fuel flowing in the annular space between the needle 14 and the valve body 26 into the chamber 29.

As provided in Figure 2 of Ren et al., the openings 40, 42 of the lower guide 32 and metering swirl disk 34 are internally located. An exterior edge of the lower guide 32 is provided along the entire periphery, thereby necessitating the more central location of an opening 40 for fluid relative to the cylindrical center orifice 18. Ren et al, therefore, provide a flow of fluid through the lower guide (and the metering swirl disk) that is different than the configuration recited in claims 23 and 34. Ren et al. do not disclose or suggest a configuration in which a guide element includes alternating recesses and tooth-shaped projecting areas along a periphery of the guide element, the recesses configured to channel fuel through the guide element. As Ren et al. do not disclose or suggest this feature, Applicants respectfully request withdrawal of the rejection to claims 23 to 30 and 32 to 34.

VIII. New Claims 35 and 36

New claims 35 and 36 have been added herein. It is respectfully submitted that claims 35 and 36 add no new matter and are fully supported by the present application, including the Specification.

It is respectfully submitted that claim 35 is patentable over the references relied upon for at least the reason that the references relied upon do not

disclose, or even suggest, at least "the diameter d sized so that an outlet plane of the outlet orifice in the projection is at least partially covered by the flattened face."

It is respectfully submitted that claim 36 is patentable over the references relied upon for at least the reason that the references relied upon do not disclose, or even suggest, "a center of the flattened face and a center of the entry plane arranged in alignment in a single axis."

IX. Conclusion

It is respectfully submitted that all pending claims are allowable. All issues raised by the Examiner having been addressed, an early and favorable action on the merits is earnestly solicited.

Respectfully submitted,

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AMENDMENT TO THE DRAWINGS:

The attached one (1) replacement sheet of drawings includes changes to Figure 3. This sheet, which includes Figures 3 and 6, replaces the replacement sheet provided on November 12, 2003. No new matter has been added. In Figure 3, the lead line indicating entry plane 110 has been corrected.

Attachment: One (1) Replacement Sheet